A CONSERVATION FOUNDATION STUDY

LIVING RESOURCES of the SEA

Opportunities for Research and Expansion

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Foreword

This book concerning life within the oceans is of extraordinary value and interest. It deals with a subject that is of importance to people throughout the world, summarizing in a manner not heretofore accomplished our present knowledge concerning the living resources of the sea.

In a major respect the book is unusual, if not unique. So often writings on any given subject represent compendia of accumulated knowledge and that is the end of them. The striking characteristic of this book is that its author, with restless purpose, seeks to demonstrate not so much what is known as what is *not known.* While this book is replete with existing information concerning marine resources, its great significance lies in the fact that it so vividly emphasizes what still remains to be learned about the life that lies within the most extensive element of our earth.

The author is under no illusion that these areas of ignorance can be easily dispelled. He recognizes, as we all must, that the dramatic advances that have occurred in the physical sciences are due in large part to the fact that the phenomena that physicists work with are regular in their properties and act predictably under given circumstances, whereas, as the author expresses it, "the principles that underlie the behavior, the abundance, the very existence of wild plants and animals, particularly those that live out of sight in the depths of the sea, are exceedingly elusive—much more difficult to discover than laws of matter and energy."

It is not as if the conquest of ignorance concerning marine life is desirable merely for some theoretical reason. Mankind has compelling need for the immeasurable quantities of self-generating resources that could be drawn from the oceans if there were sufficient knowledge and skills at our command. It is an undeniable fact that at the present time the production of organic resources from

land cultivation is not meeting the basic food requirements of today's world population in an adequate manner. This expresses the situation even too temperately, for the truth is that the majority of the world's people suffer undernourishment in varying degrees of intensity. Today the world population is increasing by more than 100,000 each day or more than 40,000,000 annually. The urgent and essential value of this book, therefore, is its contribution to thought and action so that the pressing needs of human beings can be better satisfied.

It is evident that there is a marked shortage of well-trained researchers in marine biology. With today's competition for scientists of ability, this field is not attracting its due share of talent. Further, fundamental research in marine biology must be coupled with research in the social and behavioral sciences if the sea is to become a more abundant source of food and other resources and if its products are to be widely used. The author clearly recognizes that fundamental research is expensive and demands prolonged dedication on the part of the worker. However, it is this type of research that especially calls for greater talent as well as funds, because applied research, geared to produce short-run economic returns, can more readily attract financial support. Yet such applied research can never resolve the fundamental problems that are involved.

The qualifications of Lionel Walford as the author of this study are exceptional. He is not only eminent in his field of science but at the same time is sensitive to conditions affecting human welfare. He is enriched by his contacts throughout the world, both with the scientific fraternity and with people engaged in the practical aspects of developing marine resources. He happens to have a warm interest in the problems of less developed areas and is realistic enough to be aware that the people of these countries have to resolve social as well as technical questions before increased marine resources become available to them. He rightly maintains that fundamental knowledge will best be advanced in countries that can command trained personnel and afford costly equipment. Yet he envisages that the new knowledge to be derived can, in turn, be put to use in underdeveloped countries.

The imagination of the world is presently captivated by explorations into interplanetary space, accomplished through the expenditure of huge sums of money and the exercise of remarkable talents. Yet at our doorstep, so to speak, are the great oceans containing riches that may be put to man's use but of which we still know so

little. Even though there may be no cessation of man's dramatic quests into the outer universe, is it not of first importance to discover ways of supplementing the essential requirements of humanity on the only planet which promises any guarantee of continuing existence? May this book, then, prove of far-reaching influence in pointing the way to a great and immediate task.

Fairfield Osborn
President
The Conservation Foundation

Preface

The sea is a wilderness. Threadbare though that phrase may have become in poetic literature, it still expresses an overwhelming fact. The sea is a mysterious wilderness, full of secrets. It is inhabited only by wild animals and, with the exception of a few special situations, is uncultivated. Most of what we know about it we have had to learn indirectly with mechanical contrivances designed to probe, feel, sample, fish.

This study was undertaken to determine how the harvest of sea fisheries could be substantially increased for the benefit of humanity. Human food needs are world-wide, and so therefore is the scope of this study. Emphasis, however, has been placed on the problems of those regions where population pressures and food needs are most critical.

What I have written is addressed, in effect, to everyone who is interested in the rich possibilities of the marine wilderness and is concerned with using the planet intelligently. Specifically, I hope it will prove both helpful and stimulating to fishery scientists and students who are preparing for careers concerned with fisheries; to government administrators of marine fishery agencies; to commercial fishermen, brokers, and processors; and perhaps most of all to those who direct philanthropic organizations and seek ways to disburse grants for furthering human welfare.

Although we have conquered the land as we have conquered our ignorance about it, the problem of conquering the sea is much more formidable and complex. The sea cannot be cleared or plowed, sown or fertilized, or set apart for the exclusive use of the desired animals and plants. The open sea will probably always be essentially a wild place, and we who concern ourselves with it had best accept that fact. But as we become more intimate with the world of the sea, and with the natural laws governing its inhabitants, we can develop a science of exploiting its resources and to that extent the sea need not remain a complete wilderness. One hopeful point

of attack is the inshore environment which borders many coasts. Now largely wasted, these could be cultivated economically and made to yield wondrously rich returns.

The chapters which follow focus more on what is not known than on what is known. They concern themselves with gaps, with relatively neglected subjects, and draw attention to important problems which must be solved before sea fishing can reach a level of technical competence commensurate with agricultural science. We must accept the fact that our philosophies and technologies cannot be radically changed in a hurry. It will take many years to amass the knowledge, to learn to apply it, and to persuade people to apply it. Therefore, this study is attentive as much to the foreseeable problems of generations hence as it is to those of today.

The material rewards of the special effort which all this research would require cannot honestly be foretold. The rewards in knowledge, however, could not be anything but rich, so little is our present store, and at the very least that would be its own reward.

This study was sponsored by the Conservation Foundation, and its President, Fairfield Osborn, showed monumental patience with the slow tempo of its progress. So did Lucille, my wife. Information, advice, and criticism have been sought from many people in America and abroad, and their response has been generous indeed. To all I am most grateful. Among those who have been especially helpful are Robert Snider and Peter Stern of the Conservation Foundation; John Lyman and the Hydrographer, U.S. Navy Hydrographic Office; Albert Tester, Paul Thompson, Paul Galtsoff, Raymond Gilmore, Herbert Graham, Clyde Taylor, Charles Butler, Norman Wilimovsky, John Clark, Reynold Fredin, Robert Rucker, and George Rounsefell of the United States Fish and Wildlife Service; Alfred Redfield of the Woods Hole Oceanographic Institution; Roger Revelle of Scripps Institution of Oceanography; Richard Fleming, Erling Ordal, and James E. Lynch of the University of Washington; Henry Bigelow, Elizabeth Deichmann, William H. Weston, and William Schevill of Harvard University; George S. Meyers of Stanford University; Michael Graham, D. H. Cushing, and John Corlett of the Fisheries Laboratory at Lowestoft, England; L. H. N. Cooper of the Marine Biological Laboratory at Plymouth, England; Harold Barnes, of the Marine Station, Millport, Scotland; Neville Woodward of the Institute of Seaweed Research, Midlothian, Scotland; Cyril Lucas of the Marine Laboratory, Aberdeen, Scotland; N. B. Marshall of the British Museum; Georg Wüst of the Institut für Meereskunde, Kiel, Germany; H. Friedrich, Director of the Institut für Meeresforschung, Bremen, Germany; A. Büchmann

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These good friends must not be saddled with any responsibility for the conclusions, which are wholly my own. Nor do the conclusions represent official policy in any way.

I am indebted to the American Geographical Society and to the Twentieth Century Fund for permission to use and adapt a number of maps that appeared in publications sponsored by these two organizations. The map projection I have used is the creation of William A. Briesemeister of the American Geographical Society, who also prepared the outline of the continental shelf for a map in this volume. The remainder of the graphic work was done by Gale Pasley of the Woods Hole Oceanographic Institution.

Lionel A. Walford

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